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Can oral health education be delivered to high-caries-risk children and their parents using a computer game? – A randomised controlled trial

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Background. Families of children undergoing general anaesthesia (GA) for caries management requested that oral health advice is delivered using audio-visual media.

Objective. To compare an oral health education computer game to one-to-one education.

Design. A blind randomised controlled trial of 4- to 10-year-old children scheduled for GA due to caries. Primary outcome measures were (1) parent and child satisfaction with education method; (2) improvements in child's dietary knowledge; and (3) changes in child's diet and toothbrushing habits. Measures were taken at baseline, post-intervention, and three months later.

Results. One hundred and nine families took part. Both methods of education were highly

satisfactory to children and parents. Children in both groups showed significant improvement in recognition of unhealthy foods immediately post-education ($P < 0.001$). Fifty-five per cent of all participants completed telephone follow-up after 3 months and reported improvements in diet, including reducing sweetened drinks ($P = 0.019$) and non-core foods ($P = 0.046$) intake, with no significant differences between the groups. Children reported twice-daily toothbrushing but no changes in snack selection. Attendance for a 3-month dental review was poor (11%).

Conclusion. Oral health education using a computer game can be as satisfactory and as effective in improving high-risk-children's knowledge as one-to-one education. The education received can lead to the positive dietary changes in some families.

Introduction

Dental caries in children is a global issue¹. It is a multifactorial disease that is influenced by personal dietary and oral hygiene practices and is impacted by wider socio-economic factors². Prevention of childhood caries requires a multifactorial and multiagency approach that includes the provision of health education and enhancement of life skills³. Knowledge is a prerequisite for behaviour change⁴, and thus, education remains an important element when aiming to change oral health-related behaviours.

In England, dentists have reported their frustration in preventing early childhood caries⁵. In fact, 31% of 5-year-old children have at least one carious tooth, and six per cent have five or more⁶. Furthermore, three per

cent of 5-year-olds and six per cent of 8-year-olds have had a general anaesthetic (GA) admission for tooth extraction⁶. Sadly, these children risk developing further caries, and up to a quarter need repeated treatment⁷. At King's College Hospital, one of the largest GA service providers in England, almost half of the families were re-referrals either for the same child or for a sibling⁷.

Parents of children referred for GA tooth extraction due to caries have poor oral health knowledge^{7,8} and difficulty in establishing healthy dietary and oral hygiene practices at home⁹. They have suggested that audio-visual media may be a suitable means of delivering oral health education⁷⁻⁹. It is reported that children play computer games for nine and a half hours weekly¹⁰. Educational computer games (known as 'serious games') offer a user-tailored approach, multisensory support, and problem-based learning. They can help to activate prior knowledge and can be used to motivate the player to change behaviour¹¹.

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These 'serious' games have been used for patient education regarding nutrition, hygiene, exercise, asthma, diabetes, stroke, cancer, skin cancer prevention, and preparation for surgery¹², but require further inspection in the field of oral health education.

The aim of this study was to compare an oral health education computer game to traditional one-to-one verbal oral health education, delivered by a trained dental nurse-educator.

Materials and methods

Study design

Details of the development, structure, and content of the oral health education computer game, and the methodology of this study, have already been published¹³. Briefly, this is a two-armed phase II randomised controlled trial that compared the computer game to one-to-one oral health education in a sample of children with such severe dental caries as to merit a hospital GA admission for tooth extraction. The two methods of education were compared in terms of parent and child satisfaction, oral health knowledge gain, effect on dietary and oral hygiene behaviours, and follow-up attendance 3 months later for a routine check-up (ISRCTN94617251). Ethical approval was granted by the National Research Health Ethics Service Committee London—Dulwich (Reference number: 11/LO/0220). Parents gave written consent, and the children gave written assent. The participants were recruited approximately two weeks before the GA event, at the medical pre-assessment clinic, and randomised using a computer-generated grid into (1) computer game group (study group): the child and parent played the computer game on a touch tablet and received a copy of it on a DVD to play at home and (2) one-to-one health educator group (control group): the child and parent received verbal oral health education from a dental nurse with a health education qualification.

The education messages were based on the recommendations for high-caries-risk children in the second edition of Delivering Better

Oral Health (DBOH)¹⁴ and had the same content in both groups. The methodology, especially the randomisation and blinding, was rehearsed in a pilot study. The inclusion criteria included all healthy children scheduled for GA due to dental caries, given that they were 4–10 years of age and were accompanied by a parent/guardian with sufficient English proficiency to enable consent.

Measures

Age, gender, ethnicity, and postal code deprivation score according to the 2010 English Index of Multiple Deprivation¹⁵, and number of teeth to be extracted, were recorded for all participants.

The measures collected were (1) parent and child satisfaction with their educational intervention, scored using a 100-mm visual analogue scale (VAS), where the highest satisfaction = 100 mm, collected immediately following delivery; (2) child's dietary knowledge, scored using a Pictorial Dietary Quiz (PDQ)¹⁶, taken at baseline, immediately following the educational intervention and at a 3-month follow-up dental visit; (3) child's dietary habits, scored by the parent using the Children's Dietary Questionnaire (CDQ)¹⁷, at baseline and at a 3-month telephone call. The CDQ has four parameters: fruits and vegetables; full-fat dairy; sweetened drinks; and non-core foods (those containing high amounts of saturated fat, added salt, or added sugars); and (4) the child's self-reported snacking and toothbrushing practices recorded in a diary that is given out on the day of the intervention and returned to the researcher at the GA visit.

In addition to those measures, children in the computer game group verbally reported their views on the content of the game directly to the dental nurse-educator, who recorded it verbatim, and completed a 'Secret Password Questionnaire' that verified whether or not they had played the game at home.

The lead author (AA) collected the baseline measures. A dental nurse-educator allocated the participants according to the randomisation grid and administered the immediate

post-intervention measures. She also delivered the oral health education to the control group. All data were coded and anonymised. AA administered the telephone and dental follow-up measures. He remained blinded to group allocation until after the statistical analysis was completed.

Statistical analysis

SPSS 20 was used to analyse the quantitative data. Descriptive statistics for all explanatory variables at baseline were recorded, and analysis of variance and chi-square tests were used to detect any imbalances. An independent-samples Student *t*-test was used to compare the two groups' VAS, PDQ, CDQ, toothbrushing, and snack selection scores when the data followed a normal distribution, and nonparametric tests were used when they did not. A paired-samples Student *t*-test was used to compare the baseline and post-intervention PDQ and CDQ scores. Only completed pairs of data were analysed. Verbal feedback was analysed using a simple content analysis¹⁸.

Sample size calculation

The primary outcome measure used to calculate the sample size was the participant's satisfaction with the educational intervention. This was assessed on a 100-mm VAS. Assuming a standard deviation of 25 mm¹⁹, and aiming to detect a difference of at least 15 mm between the groups²⁰, a sample of 45 participants in each group was needed to provide 80% power at the 5% significance level and to detect effects of size 0.6 and above.

Results

Recruitment

Recruitment took place between October 2013 and October 2014 at the GA medical pre-assessment clinic. Following screening, 38 potential recruits were excluded due to the parent/guardian lacking English proficiency, 13 due to the child having learning disabilities, and seven because they were already recruited to other research projects.

Eighty-eight potential participants did not attend the medical pre-assessment appointment, 134 were missed because the researcher was either busy recruiting another family at that time or due to rescheduled appointments, and seven were excluded due to the absence of the legal guardian. Of the remaining, 177 potential recruits were approached and 119 of them gave written consent. Ten participants later withdrew (Fig. 1).

Sample

The participating children had a mean age of 6.5 years (SD = 1.55 years) and were from various ethnic backgrounds, reflecting the multicultural nature of the catchment area of this paediatric dentistry service. Twenty-seven children were White British (24.8%), sixteen were Black African (14.7%), fifteen were Black British (13.8%), nine were Black Caribbean (8.3%), twelve were South Asian (11%), seven were Asian (6.4%), ten were Other White (9.2%), and finally, thirteen were from Other/Mixed Ethnic Backgrounds (11.9%).

The majority of the children came from socially deprived postcode areas, 38 (35%) came from the most deprived quintile, and 51 (47%) came from the second most deprived quintile. The children had a mean of 6.7 primary teeth extracted (range: 0–20, SD: 4.1). Ten children also had permanent teeth extracted (mean: 3.1; teeth range: 2–4, SD: 0.99). The two study groups were well matched (Table 1).

Education delivery media child and parent satisfaction

Regarding parent satisfaction, scoring was mainly at the higher end (satisfied) of the 100-mm VAS. The nurse-educator median score was 98 mm ($n = 54$; mean: 94; range: 42–100, SD: 10.2), and the computer game median score was 91 mm ($n = 55$; mean: 84.7; range: 0–100, SD: 19.9). This difference is statistically significant (independent-samples Mann–Whitney *U*-test $P = 0.003$). Regarding child satisfaction, the nurse-educator median score was 99 mm ($n = 54$; mean:

86; range: 0–100, SD: 27), and the computer game median score was 97 mm ($n = 55$; mean: 83.3; range: 0–100, SD: 25), which was not statistically significant ($P = 0.34$).

Children found the computer game 'enjoyable', 'exciting', and 'helped them learn something new'. In the words of P86, an 8-year-old, she learned that 'you can have things some times, just not all the time'. Parents found the computer game to be 'informative' and 'engaging' for their children. As mum P111 said: 'children like computer-games so they will listen carefully to the information in the game, it is very informative'. On the other hand, some children older than 7 years noted that the computer game

was 'too easy'. Younger children sometimes asked for more guidance.

Thirty-four computer game children returned the 'Secret Password Questionnaire' at the GA visit, 15 (44%) had completed it in full, and they were older than those who had not completed it (independent-samples t -test: completed mean = 7.7 years; SD = 1.6, not completed mean = 6.0 years; SD = 1.5 $P = 0.005$).

Effect on the children's dietary knowledge

All 109 children completed the 70-item PDQ at baseline, and 105 completed it immediately

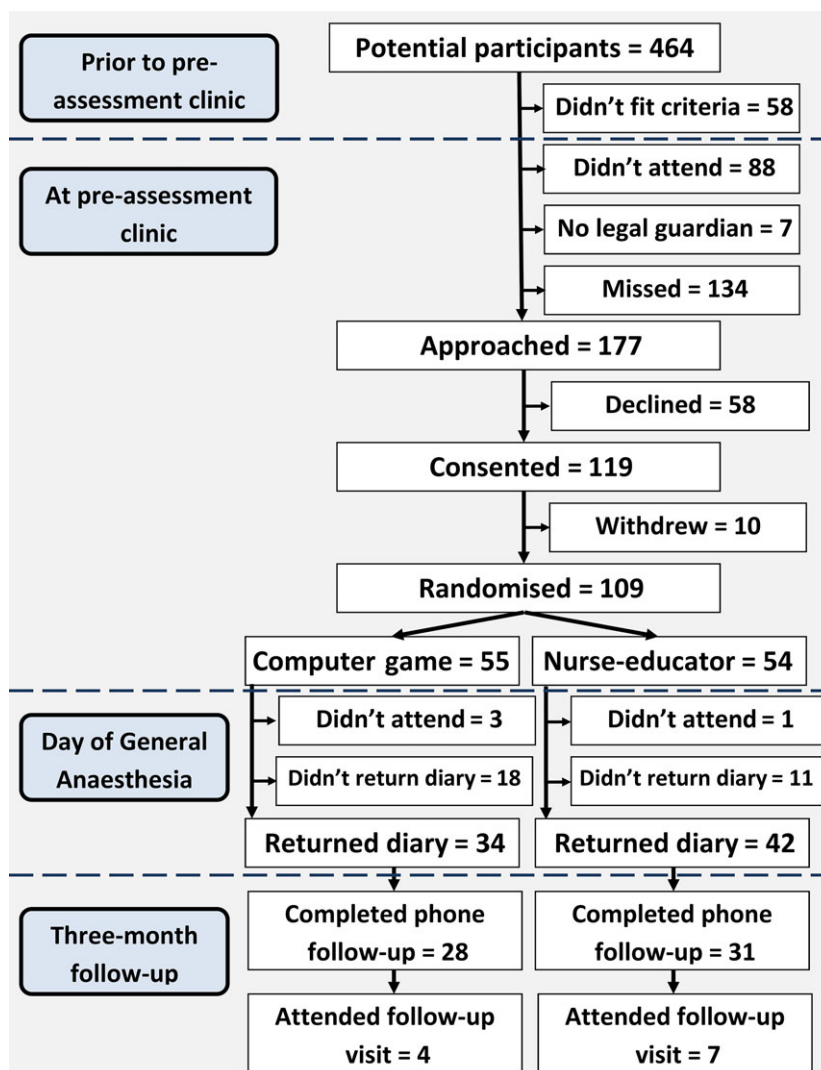


Fig. 1. Recruitment flow chart.

Table 1. Sample basic characteristics.

| Characteristic | Computer game group (N = 55) | Nurse-educator group (N = 54) |
|--|------------------------------|-------------------------------|
| Child age | 6.76 years (SD = 1.49) | 6.15 years (SD = 1.57) |
| Number of primary teeth for extraction | 6.56 teeth (SD = 4.07) | 6.76 teeth (SD = 4.12) |
| Child gender (male) | 30 (55%) | 31 (57%) |
| Accompanying guardian (mother) | 44 (80%) | 43 (80%) |
| Ethnicity (White British) | 17 (31%) | 10 (19%) |
| IMD (1st and 2nd quintile) | 45 (82%) | 44 (82%) |

following their educational intervention. There was a statistically significant improvement in the dietary knowledge of children in both groups: nurse-educator delivery led to a mean improvement of 7.6 (range: -7 to +30, SD: 9.2; paired-samples *t* tests $P < 0.001$, 95% CI: 5.1–10.1), and the computer game delivery led to a mean improvement of 4.8 (range: -3 to 26, SD: 6.4; paired-samples *t*-tests $P < 0.001$, 95% CI: 3.0–6.6). There was no significant difference between the groups (independent-samples *t*-test $P = 0.7$). Only 11 families (10%) attended the follow-up appointment 3 months later and completed the PDQ again. Hence, measuring the long-term knowledge gain was not possible (Table 2).

There was no correlation between the changes in dietary knowledge and any participant characteristic except age. Children aged 6 years or younger had lower baseline scores, and an independent-samples *t*-test showed that they had significantly more improvement overall (8.9) than those that were 7–10 years of age (3.0; $P < 0.001$; 95% CI = 3.2–8.6).

Effect on Children's Diet

One hundred and eight parents (55 in computer game group; 53 in nurse-educator group) completed the CDQ at baseline. This baseline measure showed that the children did not meet the recommended intake of fresh fruits and vegetables, and they exceeded the recommended intake of fat from dairy, sweetened drinks, and non-core foods. Fifty-nine parents (55%) completed the CDQ 3 months later by telephone (28 in computer game group; 31 in nurse-educator group). Regarding changes in dietary practices at home, parents in the computer game group reported a statistically significant reduction in sweetened drink intake from baseline (paired-samples *t*-test $P = 0.008$; 95% CI = -1.1 to -0.2]. When data were pooled, there were statistically significant improvements in the children's diets; with respect to reduced intake of non-core foods [$P = 0.046$; 95% CI = -0.6 to 0], fat from dairy [paired-samples *t*-test $P = 0.037$; 95% CI = -1.3 to 0],

Table 2. Changes in child's dietary knowledge following intervention.

| | Computer game (N = 55) | Nurse-educator (N = 54) | Total |
|--|------------------------|-------------------------|-----------|
| Baseline pictorial dietary quiz score | | | |
| Missing | 0 | 0 | 0 |
| Score range | 27–66 | 31–66 | 27–66 |
| Mean | 56.0 | 53.4 | 54.7 |
| SD | 9.6 | 10.6 | 10.1 |
| Post-intervention pictorial dietary quiz score | | | |
| Missing | 4 | 0 | 4 |
| Score range | 41–68 | 44–69 | 41–69 |
| Mean | 60.6 | 61.1 | 60.9 |
| SD | 6.0 | 5.1 | 5.5 |
| Change in pictorial dietary quiz score | | | |
| Range | -3 to +26 | -7 to +30 | -7 to +30 |
| Mean | +4.8 | +7.6 | +6.2 |
| SD | 6.4 | 9.2 | 8.0 |
| 95% CI | 3.0–6.6 | 5.1–10.1 | 4.7–7.8 |
| <i>t</i> -test <i>P</i> value | <0.001* | <0.001* | <0.001* |

*Statistically significant.

and sweetened drinks [$P = 0.019$; 95% CI = -0.8 to -0.1]. The improvements were not enough to meet the recommended CDQ standards except in the non-core foods' category. There were no statistically significant differences between the groups in any category. These results are detailed in Tables 3 and 4.

It is noteworthy that those who completed the 3-month telephone follow-up (55%) reported a significantly lower intake of sweetened drinks ($n = 59$; $P = 0.02$; 95% CI = 0.1 – 1.3) at baseline compared to non-respondents (45%).

Effect on the children's self-reported snack selection

At baseline, all 109 children reported having a snack at school or at home, 74 children (68%) reported having a healthy snack and 35 (32%) had an unhealthy snack. There were no differences between the groups.

A total of 76 snack diaries were returned (34 in computer game group; 42 in nurse-educator group). The return rate for both

groups was the same (Chi-square test $P = 0.07$). Neither method of education delivery significantly changed the children's snack selection (related-samples Wilcoxon signed rank test: computer game $P = 0.95$; nurse-educator $P = 0.89$).

Effect on the children's toothbrushing frequency

Seventy-six children (70%) returned toothbrushing diaries (34 in computer game group; 42 in nurse-educator group). Children reported brushing twice daily (mean = 1.9; median = 2.0; SD = 0.2), and this was irrespective of group [Mann–Whitney U -test: $P = 0.44$].

Effect on the child's dental attendance

Fifty-nine (55%) parents completed the 3-month follow-up telephone call (28 in computer game group; 31 in nurse-educator group). 26 (93%) of those in the computer game group, and 22 (71%) in the nurse-educator group, reported that they thought that

Table 3. Children's dietary practice: sweetened drinks 3 months after the general anaesthesia.

| | Computer game ($N = 55$) | Nurse-educator ($N = 54$) | Total |
|---|----------------------------|-----------------------------|---------------|
| Missing | 27 (49%) | 23 (43%) | 50 (45%) |
| Sweetened drinks intake (3 months after GA) | | | |
| Score range | 0–4.4 | 0–6.3 | 0–6.3 |
| Mean (recommended: ≤ 1) | 1.4 | 1.7 | 1.6 |
| SD | 1.2 | 1.4 | 1.3 |
| Mean change from baseline score | –0.6 | –0.3 | –0.5 |
| SD | 1.2 | 1.7 | 1.5 |
| 95% CI | –1.1 to –0.2 | –0.9 to 0.3 | –0.8 to –0.1 |
| t -test P value | 0.008* | 0.33 | 0.019* |

*Statistically significant.

Table 4. Children's dietary practice: non-core foods 3 months after the general anaesthesia.

| | Computer game ($N = 55$) | Nurse-educator ($N = 54$) | Total |
|---|----------------------------|-----------------------------|---------------|
| Missing | 27 (49%) | 23 (43%) | 50 (45%) |
| Non-core foods intake (3 months after GA) | | | |
| Score range | 0.6–4.9 | 0.9–3.6 | 0.6–4.9 |
| Mean (recommended: ≤ 2) | 1.9 | 2.0 | 1.9 |
| SD | 0.92 | 0.80 | 0.85 |
| Mean change from baseline score | –0.2 | –0.4 | –0.3 |
| SD | 1.0 | 1.3 | 1.2 |
| 95% CI | –0.6 to 0.2 | –0.9 to 0.1 | –0.6 to 0 |
| t -test P value | 0.24 | 0.11 | 0.046* |

*Statistically significant.

three-monthly dental check-ups were needed, but only 11 from the total sample (10%) actually attended a follow-up appointment at the hospital, although a further 15 (14%) reported that they had visited or contacted their local dentist.

Discussion

The families of high-caries-risk children, and the children themselves, were highly satisfied with the oral health education computer game. Parents gave the nurse-educator a statistically significant higher satisfaction score than the computer game on our 100-mm VAS; however, this score difference was less than the 11 mm needed to be deemed clinically meaningful²⁰. Children, meanwhile, found the computer game interesting, engaging and as satisfactory as the personal delivery by the oral health educator, but some older children found the game 'too easy' and in fact did not gain as much new dietary knowledge as those who were younger. Just over a quarter of families (27%) played the game again at home. Gaining the user's interest and demanding the right amount of interaction are important for computer game appeal²¹. As such, future oral health computer games will need to have better age targeting. In addition, as it seems that not all high-caries-risk families will use a 'serious' game at home, enabling access within the dental clinic, perhaps as part of a dental visit, will still be needed.

This study confirms that high-caries-risk children have unhealthy diets²². As such, it was pleasing to see that children who used the computer game improved their recognition of healthy and unhealthy foods in a similar manner to those educated by an oral health educator. This confirms the results of the phase I RCT that assessed this game's earlier prototype¹⁶ and is in concordance with other studies evaluating nutrition education video games in children^{23–25}. In addition, it was encouraging to note that the consumption of non-core foods by children in the sample was reduced sufficiently to reach a healthy standard on the CDQ¹⁷. Even if the parents had overemphasised the changes in their child's diet, they at least demonstrated

that they had gained knowledge. Moreover, all of the children reported twice-daily tooth-brushing, and this type of child self-reporting is suggested to be reliable²⁶.

Most parents knew that their children should attend for regular dental care, but only 10% attended a follow-up visit despite flexible scheduling, telephone calls, and text message reminders. The families in this cohort are already known to be poor dental attenders^{7, 27}. Interestingly, a study to deliver verbal and written advice to a similar family cohort in the USA did not lead to better attendance either²⁸. Another study that delivered verbal advice supplemented with visual aids resulted in good attendance at a follow-up appointment, but this was only 2 weeks following the GA and might have been regarded as a surgical review visit²⁹.

It is well known that oral health education alone does not necessarily lead to behaviour change³⁰, especially when it is a 'one-off' intervention. Nonetheless, knowledge is an important component of behaviour change⁴. As such, the findings of the present study, in relation to the potential value of 'serious' games in delivering oral health educational messages, are positive.

This study suggests that a 'serious' game can be used as an adjunct to oral health education, although longer follow-up research is needed. Children need to be directly engaged in oral health education; they can transmit knowledge to their parents and can exert control over their own, and their families', dietary selection³¹. In fact, food companies have been targeting children through mass media using child-friendly characters³². Thus, providing oral health education in a child-friendly manner, such as using a computer game, might help gain children's attention and expose their families to a more positive oral health message. As such, these games might be of value when integrated into wider public health campaigns.

This study had its limitations. Firstly, the VAS used to score satisfaction had a 'ceiling effect', in a manner similar to that noted by Brokelman *et al.*¹⁹; however, this is still a well-validated measure that displays a lower ceiling effect than a Likert scale when satisfaction is

being measured³³. Secondly, the PDQ only assessed the child's identification of 'healthy' or 'unhealthy' foods, whereas a good diet is about having balanced nutrients. As such, future research should aim to develop and validate more sophisticated tools to measure the dietary knowledge in children and parents. Thirdly, evaluation of the long-term retention of the children's dietary knowledge, as we had originally intended, was not possible due to the poor attendance of the follow-up appointment. Finally, only 55% of the recruited sample completed the telephone follow-up 3 months after the child's GA. Hence, the reported dietary improvements need to be interpreted with caution.

This study also had its strengths: by providing evidence in the form of an RCT comparing interactive education with traditional personal oral health educator delivery, it has addressed a deficit in educational computer game research¹². Furthermore, it showed that children and families from poorer socio-economic backgrounds could be motivated to participate in media-based studies. Previous developers of diet education computer games only targeted school children across the wider socio-economic groups and did not target a particular high-risk population^{23–25}. The only other study that did target high-risk children had a small sample size (ten participants in each group)³⁴.

The sample in the present study compares well to children attending for dental GA across the UK, in terms of average age and treatment needs^{35,36}. They are children under high risk of developing dental caries, the most prevalent disease of childhood in the world today¹. The majority of children in the UK have access to audio-visual media¹⁰. In fact, the government plans to have high-speed broadband available to 90% of the population by the end of 2016. Governments around the world are investing in audio-visual technologies, and the research, such as this, on how these advancements can be utilised for health promotion is needed.

In conclusion, the findings of this study suggest that high-carries-risk children and their families find the delivery of oral health education using a computer game highly

satisfactory. Using the game can improve children's recognition of unhealthy food items such as sweetened drinks and non-core foods. The education received can help some families introduce positive dietary changes; however, further research is needed to explore the long-term impact of using this tool for oral health education and how the education delivered to this cohort can be supported by wider health promotion action that facilitates and retains good oral health practices.

Why this paper is important for paediatric dentists

- It explores the potential of modern, commonly available, and child-friendly media in delivering oral health education.
- It explores the delivery of oral health advice to high-carries-risk children and their families, a cohort frequently encountered by paediatric dentists and in desperate need for oral health interventions.

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Author contributions

All authors contributed to the design of the study. AA was responsible for daily trial management and patient selection and recruitment, with MTH and JG providing supervision. All authors contributed to writing and approval of the paper. All authors read and approved the final manuscript.

Conflict of interest

The authors declare that they have no competing interests.

References

- 1 Vadiakas G. Case definition, aetiology and risk assessment of early childhood caries (ECC): a revisited review. *Eur Arch Paediatr Dent* 2008; **9**: 114–125.

- 2 Arora A, Schwarz E, Blinkhorn AS. Risk factors for early childhood caries in disadvantaged populations. *J Investig Clin Dent* 2011; **2**: 223–228.
- 3 World Health Organization Ottawa charter for health promotion: an International Conference on Health Promotion, the move towards a new public health. World Health Organization, 1986; <http://www.who.int/healthpromotion/conferences/previous/ottawa/en/> [Accessed September 30, 2016].
- 4 Michie S, West R. Behaviour change theory and evidence: a presentation to Government. *Health Psychol Rev* 2013; **7**: 1–22.
- 5 Aljafari AK, Gallagher JE, Hosey MT. Failure on all fronts: general dental practitioners' views on promoting oral health in high caries risk children—a qualitative study. *BMC Oral Health* 2015; **15**: 1. doi:10.1186/s12903-015-0032-8.
- 6 Health and Social Care Information Centre: Children's Dental Health Survey 2013 Report 2: Dental Disease and Damage in Children: England, Wales and Northern Ireland. 2015; <http://www.hscic.gov.uk/catalogue/PUB17137/CDHS2013-Report2-Dental-Disease.pdf> [Accessed September 30, 2016].
- 7 Olley RC, Hosey MT, Renton T, Gallagher J. Why are children still having preventable extractions under general anaesthetic? A service evaluation of the views of parents of a high-caries-risk group of children. *Br Dent J* 2011; **210**: E13. doi:10.1038/sj.bdj.2011.313.
- 8 Karki AJ, Thomas DR, Chestnutt IG. Why has oral health promotion and prevention failed children requiring general anaesthesia for dental extractions? *Community Dent Health* 2011; **28**: 255–258.
- 9 Aljafari AK, Scambler S, Gallagher JE, Hosey MT. Parental views on delivering preventive advice to children referred for treatment of dental caries under general anaesthesia: a qualitative investigation. *Community Dent Health* 2014; **31**: 75–79.
- 10 OFCOM. Children and Parents: Media Use and Attitudes Report 2014. <http://stakeholders.ofcom.org.uk/market-data-research/other/research-publications/childrens/children-parents-oct-14/> [Accessed September 30, 2016].
- 11 Oblinger DG. The next generation of educational engagement. *J Interact Media Educ* 2004; **8**: 1. Art-10
- 12 Primack BA, Carroll MV, Mcnamara M *et al.* Role of computer-games in improving health-related outcomes: a systematic review. *Am J Prev Med* 2012; **42**: 630–638.
- 13 Aljafari A, Rice C, Gallagher JE, Hosey MT. An oral health education video game for high caries risk children: study protocol for a randomized controlled trial. *Trials* 2015; **16**: 237.
- 14 Department Of Health Delivering Better Oral Health: An evidence-based toolkit for prevention, Second Edition. 2009; http://webarchive.nationalarchives.gov.uk/20130107105354/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalassets/dh_102982.pdf [Accessed September 30, 2016].
- 15 Department for Communities and Local Government. English indices of deprivation 2010; 2011. <https://www.gov.uk/government/statistics/english-indices-of-deprivation-2010>
- 16 Rice C, Hosey MT. Interactive oral health education – a randomised controlled trial. *Eur Arch Paediatr Dent* 2008; **Abstracts of EAPD Congress 2008**: 20–21.
- 17 Magarey A, Golley R, Spurrier N, Goodwin E, Ong F. Reliability and validity of the Children's Dietary Questionnaire; a new tool to measure children's dietary patterns. *Int J Pediatr Obes* 2009; **4**: 257–265.
- 18 Ritchie J, Lewis J. Qualitative research in practice: A guide for social science students and researchers. London: Sage, 2003.
- 19 Brokelman RBG, Haverkamp D, Van Loon C, Hol A, Van Kampen A, Veth R. The validation of the visual analogue scale for patient satisfaction after total hip arthroplasty. *Eur Orthop Traumatol* 2012; **3**: 101–105.
- 20 Singer AJ, Thode HC. Determination of the minimal clinically significant difference on a patient visual analog satisfaction scale. *Acad Emerg Med* 1998; **5**: 1007–1011.
- 21 Connolly TM, Stansfield MH, Hainey T. Development of a general framework for evaluating games-based learning. In: Proceedings of the 2nd European conference on games-based learning (pp. 105–114). Universitat Oberta de Catalunya Barcelona, Spain; 2008.
- 22 Llena C, Forner L. Dietary habits in a child population in relation to caries experience. *Caries Res* 2008; **42**: 387–393.
- 23 Amaro S, Viggiano A, Di Costanzo A *et al.* Kaledo, a new educational board-game, gives nutritional rudiments and encourages healthy eating in children: a pilot cluster randomized trial. *Eur J Pediatr* 2006; **165**: 630–635.
- 24 Baranowski T, Baranowski J, Cullen KW *et al.* Squire's Quest! Dietary outcome evaluation of a multimedia game. *Am J Prev Med* 2003; **24**: 52–61.
- 25 Turnin MC, Tauber MT, Couvaras O *et al.* Evaluation of microcomputer nutritional teaching games in 1876 children at school. *Diabetes Metab* 2008; **27**(4 Pt 1): 459–464.
- 26 Jamieson LM, Thomson WM, Mcgee R. An assessment of the validity and reliability of dental self report items used in a National Child Nutrition Survey. *Community Dent Oral Epidemiol* 2004; **32**: 49–54.
- 27 Goodwin M, Sanders C, Pretty IA. A study of the provision of hospital based dental general anaesthetic services for children in the northwest of England: part 1 – a comparison of service delivery between six hospitals. *BMC Oral Health* 2015; **15**: 50. doi:10.1186/s12903-015-0028-4.
- 28 Primosch RE, Balsewich CM, Thomas CW. Outcomes assessment an intervention strategy to improve parental compliance to follow-up evaluations after treatment of early childhood caries using general anesthesia in a Medicaid population. *ASDC J Dent Child* 2001; **68**: 102–108.
- 29 Picard AJ, Estrella MR, Boynton J, Maxwell A, Inglehart MR. Educating parents of children receiving comprehensive dental care under general

- anesthesia with visual AIDS. *Pediatr Dent* 2014; **36**: 329–335.
- 30 Kay EJ, Locker D. Is dental health education effective? A systematic review of current evidence. *Community Dent Oral Epidemiol* 1996; **24**: 231–235.
- 31 Roberts BP, Blinkhorn AS, Duxbury JT. The power of children over adults when obtaining sweet snacks. *Int J Paediatr Dent* 2003; **13**: 76–84.
- 32 Rodd HD, Patel V. Content analysis of children's television advertising in relation to dental health. *Br Dent J* 2005; **199**: 710–712.
- 33 Haverkamp D, Sierevelt IN, Van Den Bekerom MP, Poolman RW, Van Dijk CN, Marti RK. The validity of patient satisfaction as single question in outcome measurement of total hip arthroplasty. *J Long Term Eff Med Implants* 2008; **18**: 145–150.
- 34 Pempek TA, Calvert SL. Tipping the balance: use of advergames to promote consumption of nutritious foods and beverages by low-income African American children. *Arch Pediatr Adolesc Med* 2009; **163**: 633–637.
- 35 Camilleri A, Roberts G, Ashley P, Scheer B. Analysis of paediatric dental care provided under general anaesthesia and levels of dental disease in two hospitals. *Br Dent J* 2004; **196**: 219–223.
- 36 Macpherson LM, Pine CM, Tochel C, Burnside G, Hosey MT, Adair P. Factors influencing referral of children for dental extractions under general and local anaesthesia. *Community Dent Health* 2005; **22**: 282–288.